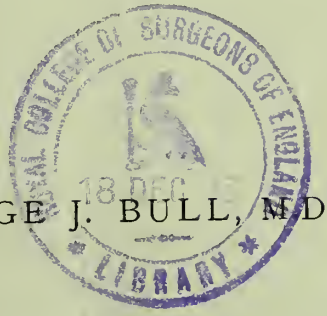
(2.) To Professor Tweedy
with the author's compl

OPTOMETRY

BY THE

SUBJECTIVE METHOD

A Paper Read at the Meeting of *The British Medical Association*, London, July, 1895.



By GEORGE J. BULL, M.D. *(Paris)*.

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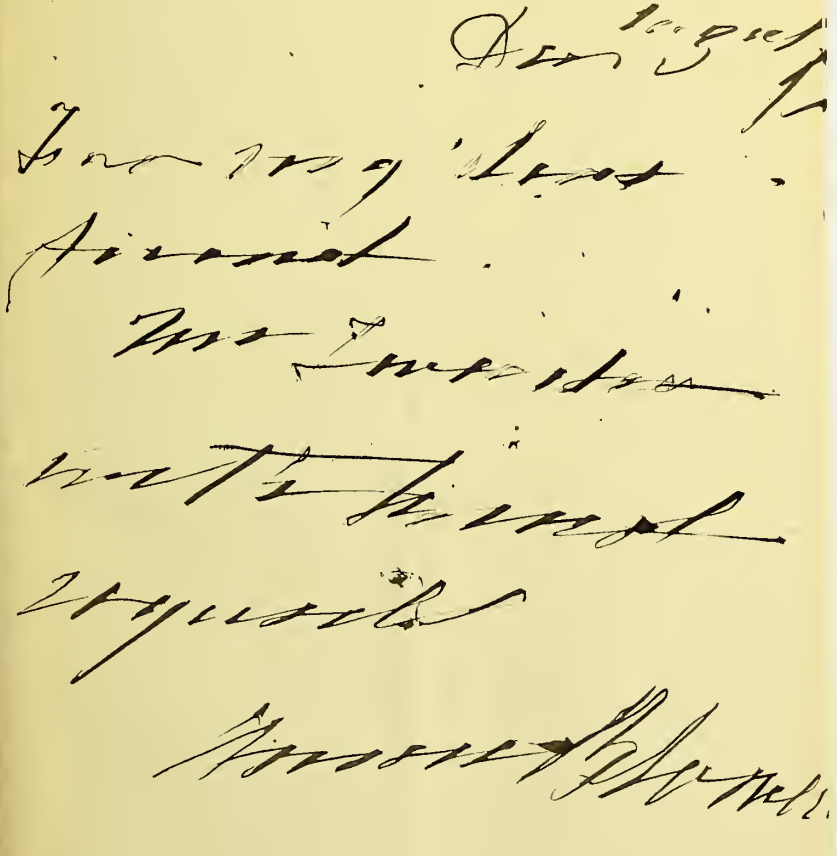

OPTOMETRY BY THE SUBJECTIVE METHOD.

A Paper read at the Meeting of the British Medical Association, London, July, 1895.

By Dr. GEORGE J. BULL (*Paris*).

IN the present state of ophthalmological science it is obviously impossible to dispense with the subjective methods of optometry.

Every experienced practitioner, however, will be aware that the exactitude of these methods is impaired by many serious sources of error. The object of the present paper is to direct attention to certain considerations by which some of the most important of these dangers may be largely eliminated.

Subjective optometry is, by the nature of the case, to be divided in practice into the diagnosis of ametropia in general, and the specific diagnosis of astigmia.

The considerations to which I would direct attention have relation to the relative priority of these parts of the examination. If the patient be first examined by general tests for the purpose of determining the degree of myopia or hypermetropia, as the case may be, while the possible presence or degree of his astigmia is undetermined, the conclusions to be drawn from his answers will, according to my experience, be liable to very large elements of error.

It is a commonplace of ophthalmological practice that it is much more difficult to determine correctly mixed or hyperopic astigmia than it is to determine the exact correction of myopic astigmia. This difficulty led me, for my own guidance, to state the problem presented in our practice in the following form :—

The presence of astigmia manifestly affects the range of accommodation towards the remote point and also towards the near point, but leaves it practically unaffected in the intervening space. Let us say, therefore, that the range in the case of the astigmic patient may be divided into three zones. Supposing, for the sake of clearness, that we assume a full range of 4D. of accommodation in an eye of which the horizontal meridian is emmetropia, while the vertical meridian has 1D. of myopia. The result of this 1D. of astigmia is to resolve the range into what I venture to call a *remote zone* of 1D. in extent, within which the patient can accommodate for vertical lines,

and not for horizontal lines; a *mean zone* of 3D. in extent, in which he can accommodate for either; and a *near zone* of 1D. in extent, in which he can accommodate for horizontal lines and not for vertical ones, as is indicated in Diagram I.

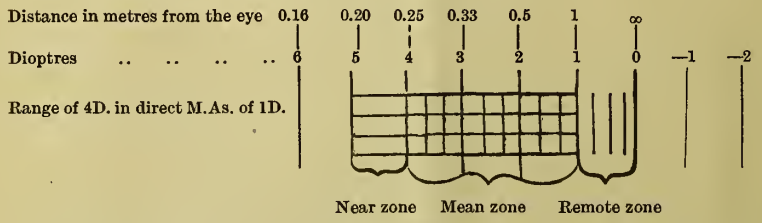

Diagram I.

If an object containing both horizontal and vertical lines is exhibited to this patient anywhere in the mean zone, he will be able to see it with a degree of distinctness practically sufficient for ordinary purposes, because, although at any one instant the vertical lines may be to him different from the horizontal, he can in practice focus first for the one and then for the other by an alternating arrangement of extreme rapidity, of which he is probably altogether unconscious, and which, in the processes of ordinary life, has become perfectly habitual to him. This, at least, appears to me to be the correct account of his method of vision. My present point, however, is that, if he were asked to look at the clock lines either with the naked eye at a distance which was in fact in the mean zone of his range, or with any spherical glasses which would produce an equivalent result, he would probably declare, even if he were a very accurate observer, that he saw no difference in the distinctness of vertical and horizontal lines. If, however, the same object were presented to him anywhere in his remote zone, he would be able to focus for the vertical lines, and would consequently declare that he saw them with distinctness; but he would be wholly unable to focus for the horizontal lines, and would consequently be obliged to report that he saw them blurred.

This appears to me to afford us a simple and logical formula by which certain important possibilities of error in the subjective method may be avoided. That formula is that *astigmia should in practice be examined only in the remote zone.**

Having stated the principle, it may be convenient that I should now restate the problem as it appears under the ordinary conditions of the consulting-room. It will be apparent from what I have said

* It is obvious that the examination might be applied in the *near zone*, but in practice this is never desirable.

that it will in many cases make a very important difference whether the examination for general ametropia is or is not carried forward to its apparent conclusion, before the observer has determined the extent to which astigmia may be present. I can best illustrate this by a concrete case.

If, for example, we suppose a patient with a general myopia of 2D., who has at the same time a direct myopic astigmia of 1D., the existence of which is as yet unknown to the observer, what may happen is obvious. If the observer begins by endeavouring to determine the degree of general myopia, by following the common rule of giving the weakest concave spherical glass which most improves the visibility of distant test-types, he will find that the patient sees best with —2·5 or —3, and the patient will certainly prefer —3 to —2. The fact is that in the given case the use of the —3 glass will cause the astigmia to be almost entirely masked, because at that point the patient can probably accommodate without any conscious difficulty for any or all of the lines of the clock, as will be evident by the second of the scales in the appended Diagram II. The clock is now in effect in his mean zone. If, therefore, the patient is not asked to look at the clock dial until the general ametropia has been, as it is supposed, completely corrected, the probability is that the astigmic patient will not observe any difference in the lines, and that his answers, however subjectively accurate, will be in fact misleading.

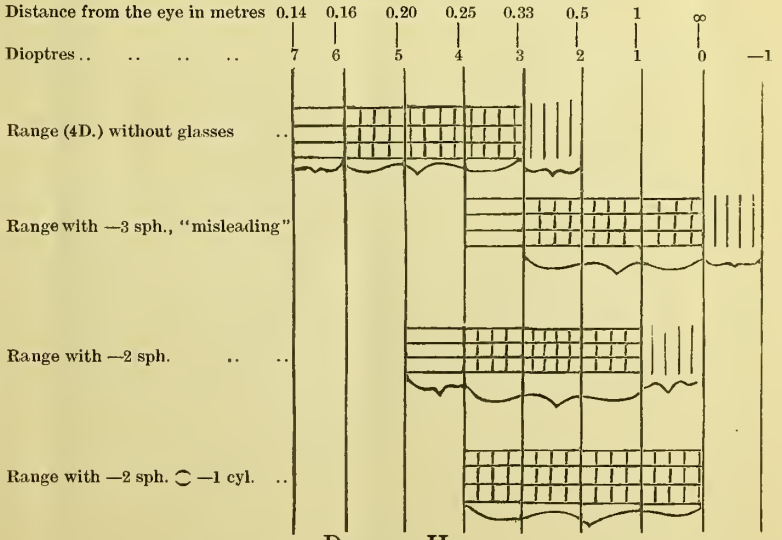

Diagram II.

If, on the contrary, the presence of astigmia had been first of all determined, the source of error in question could be eliminated with-

out difficulty. Leaving objective methods out of consideration for the present purpose, it is quite possible to arrive, by a careful use of subjective optometry alone, at a very accurate result by the simple process of referring the patient to the clock-dial at an early stage of the examination, when his vision is in the condition of what I may call the *appropriate myopia*.

In the case supposed, the condition is arrived at by the very simple expedient of referring him to the clock-dial as soon as the observer has found the weakest spherical glass with which any one of the radii can be distinctly seen. As a matter of precaution, the process might be commenced with an even weaker glass, but all that is essential is that the trial of concave spherical glasses shall not be pressed beyond the point I have described.

In the case above supposed, the glass in question will be—2. Leaving this glass in the trial frame, let the patient now be given concave cylindrical glasses with their axis at right angles to the line which is distinctly seen until the transverse lines are seen with equal clearness. The weakest cylindrical glass which equalizes the lines represents the value of the astigmia, and the possibility of the error referred to has been eliminated.

Those who have done me the honour to follow the earlier portion of this paper will not need to be told that what we have done in effect is to exhibit the clock-dial under such circumstances that it is in effect at or near the remoter limit of the remote zone, as will be seen by the third of the scales in Diagram II. above. My own practice is always to transfer the patient's range of accommodation to such a point as will bring my clock-dial to a position a little beyond the *punctum remotum* of his meridian of least refraction.

In hyperopic, or mixed cases, the same principle of reduction in the first place to the appropriate myopia can be applied with equal exactitude. Suppose, for example, a patient has an unsuspected direct astigmia of 1D., with a general hypermetropia of 2D. The process would then be to bring his range of vision back by convex spherical glasses, without regard to the clearness of the letters, as long as any of the lines in the clock-dial remain clearly visible. In the case supposed, he would then have in the trial frame a convex spherical glass of about 3D. For the purpose of our diagnosis he is then in precisely the same condition as the last case, and it is only necessary to give him concave cylindrical glasses in the transverse axis until the lines are equalized. The clock is, in fact, again brought to somewhere about the remoter limit of the remote zone, the whole range having been first transferred so as to imitate the simple case of myopic

astigmia. This condition and its correction in the manner suggested may be illustrated by the annexed Diagram III.

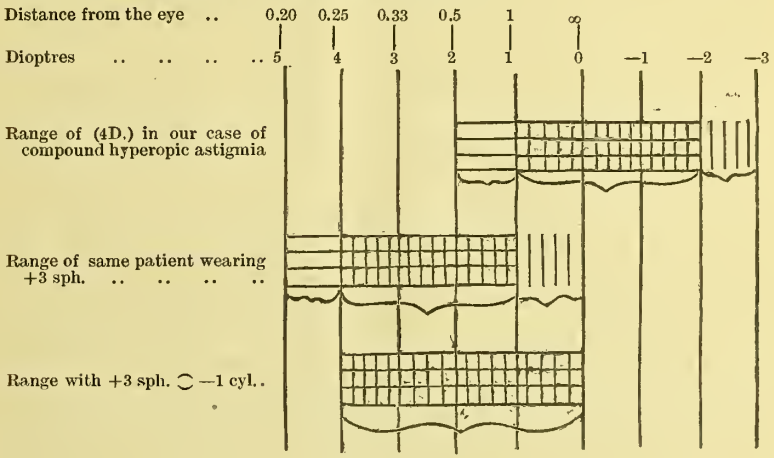

Diagram III.

The astigmia being now reliably determined, the diagnosis of the general ametropia can be completed by the obvious process of leaving the cylindrical glasses in situ, and trying back with spherical glasses, according to the ordinary rule, until we have found the weakest concave or the strongest convex spherical glass with which the distant test-types are best seen.

It will be observed that, by the method proposed, the familiar difficulty of hyperopic astigmia is removed by the simple expedient of converting the problem in each case into the myopic form. This I suggest, is not only convenient in practice, but is also the logical and appropriate method of resolving correctly the problem which is presented to the practitioner. I suggest, therefore, that the conclusion arrived at may be easily and correctly set out in some such rule as this:—

"Before attempting to correct the general ametropia, determine the meridian of least refraction, if any; make that meridian slightly myopic, and at once determine the astigmia exactly by means of concave cylindrical glasses in the transverse axis; finally, with the cylindrical glass in situ, complete the correction of the general ametropia by adjusting the spherical glasses according to the common rule."

It will be obvious to those who have followed the reasoning of my paper that this rule may be more briefly stated in the form: "Make all astigmia myopic, and then measure it in the remote zone."

It is an incidental but a useful corollary of this method that

it obviates the harassing and unsatisfactory process of trying backwards and forwards with concave and convex cylindrical glasses under circumstances which make it almost certain that the patient's answers will become confused; and also that it dispenses entirely with the necessity of resorting to the use of mydriatics for the purposes of subjective optometry.

APPENDIX.

It may be appropriate to add here a somewhat fuller explanation of certain phenomena which characterise astigmic vision in the outer zones. It is hardly necessary to observe that the diagrams printed with the text are by no means intended to indicate that the vertical or horizontal elements (as the case may be) disappear the moment the object is carried out of the mean zone. On the contrary, a distinct factor in the trouble and uncertainty of astigmic vision is the persistance, at certain ranges, of blurred or doubled elements lying in one meridian in combination with fairly distinct elements in the transverse meridian. It would be approximately correct to say, if we take as the unit of visibility an object subtending an angle of five minutes at the retina, that each unit may be expected to continue to be more or less visible for a range of ¼ or 3D. beyond the *punctum remotum*, and probably for a relative distance within the *punctum proximum*, although in the latter case it is, under ordinary circumstances, difficult to determine the vanishing point with accuracy because of the rapid increase in the apparent size of any given object.*

The diagrammatic representation of the zones of vision in an astigmic eye, such as that to which Diagram I. refers, might, therefore, be more justly represented by some such scheme as the following: —

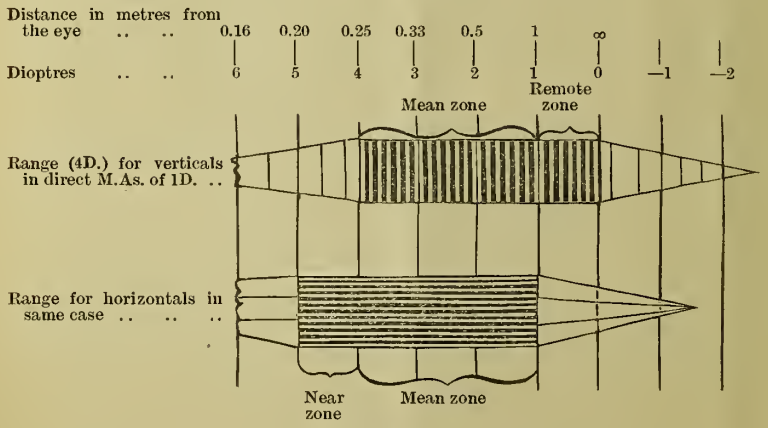

Diagram IV.

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* The determination may of course be made if desired by using a series of test objects decreasing proportionately in magnitude as each approaches the eye. I have constructed such an optometer for my own use, and have found it of some service.

Such a diagram may make it easier, for example, to realise how a cathedral or a tree would look to an artist having the given kind and degree of astigmia. If the object were so placed as to be in his "remote zone," he would see the pillars of the architecture or the trunk of the tree correctly, but his vision of the transverse galleries or of the branches would be distorted and impaired. If it were so placed as to lie, for him, between ∞ and -1, he would see both less clearly, but would still be able to make out something of the general effect. If it were a dioptre further off again, he would practically or wholly lose the horizontal elements, and would see a picture in which the verticals would predominate altogether, although they also would be very much blurred and very badly seen. He might still see a good deal of the main outlines of any scheme in which the vertical lines were the most essential characteristic.

It is important to observe that the vertical or horizontal elements (as the case may be) seem to undergo, as they pass away from the limit of their zone of accommodation, an optical process of dissipation or resolution as to which I have observed a number of interesting phenomena. It may be stated generally, in the first place, that as we travel beyond the limit of the zone of accommodation, the apparent width of a limit line will be continuously increased, and its intensity continuously diminished, in a manner corresponding to the effect upon a pencil of light of a progressive spherical aberration. The process of dissipation, however, assumes various forms which may be broadly classified as follows.—

a. The simplest form is that in which the elements seen by the meridian which is unable to focus the object perfectly, are distinguished only by loss of definiteness of outline, diminution of intensity and increase of apparent width.

b. In another series of cases one edge of the line appears to remain relatively distinct, while the other edge is resolved into a penumbra.

c. In a third series of cases, which characterise that part of what I may call the cone of dissipation, which approaches the vanishing point, the weak line is only faintly recognised as a diffused band of shadow of relatively great width, often, for example, as much as quadruple the apparent size or more. If the observation be pressed in this stage by adding the appropriate glasses, the gradual dissipation of the shadow may be easily followed right up to the point of the cone.

d. At certain points, the process of dissipation takes the interesting specific form of a reduplication of the original line, in the phenomenon commonly spoken of as "doubling." It would be incorrect, however, to assume that this condition is in reality a mere doubling of the original line. It is probably more correct to describe the appearance as a resolution of the line, first into two comparatively narrow dark bands, with an intermediate band of white or grey, and in a further stage into three dark bands separated by two light ones. I have even found it possible in a limited number of cases to identify four or more of these dark resolution lines, but in these instances the intensity is already weakened to such a degree that the case is hardly to be distinguished from the condition of general diffused shadow described above under *c*.

The phenomenon of doubling is, of course, familiar in one form or another to all who have studied astigmia. It may, however, be useful to observe that many persons in an astigmic condition will

describe their vision of any of the larger letters in the test-types by saying that they see it as if there were several letters *superposed* in such a manner that the main image in the centre would be overlaid on the one side by one or more faint reduplications, and on another side by a similar series. Such a person (supposing the astigmia to be direct) may for example in looking at the large C, observe a faint letter displaced upwards and another faint letter displaced downwards, and if he does he will probably notice that the area where these images coincide with the position of the actual letter in the centre, becomes prominent as a very black and striking portion of the figure seen.

One cause of the difficulty which an astigmic patient experiences in seeing such a letter correctly is that the shape of this prominent portion of the field may be entirely different from the shape of the original letter. It would, however, be misleading to suggest that these appearances are specially characteristic of astigmia, as distinguished from other errors of refraction, since the apparent partial superposition of multiple images may be observed in other forms of refrac tive error.

It is of considerable importance for practical as well as theoretic purposes that these phenomena should be accurately observed, and this is not always easy. I have found, for example, that astigmic patients often find it difficult to answer definitely as to the relative values of the lines of the clock, apparently because of the somewhat puzzling changes through which the different meridians pass rapidly as the patient observes them through a consecutive series of lenses. This observation has led me for my own convenience to substitute for the clock-face a simpler, but in my experience a more delicate and reliable instrument. This consists of a rotatory disc, carrying only two lines at right angles to each other, which I call *the cross*. I find that the patient, having only two lines to compare, is able to observe slight doublings or shadows, or slight differences in the intensity and definition of these two lines, much more accurately than he can observe the precise differences of value between the various lines of the clock. The way in which I am accustomed to work is to first determine roughly with the clock, using spherical lenses only, the general direction of the meridian of least refraction, and then to ascertain more closely by means of the cross the exact position in which this meridian lies.

At this point I direct the patient's attention to the line of the cross perceived by his meridian of least refraction, and correct that meridian carefully with a spherical lens. When this is accomplished, it is comparatively easy to find the concave cylindrical glass by which the transverse line of the cross is made equally definite and intense.